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MEDALS OF THE NATIONAL ACADEMY OF SCIENCES[1]

PRESENTATION OF THE DANIEL GIRAUD ELLIOT MEDAL AND HONORARIUM TO RICHARD SWANN LULL

THOUGH I was not a member of the committee that made this award, I heartily concur in the propriety of it, and am especially glad that the long-continued and admirable labors of Professor Lull are receiving recognition which, though belated, will undoubtedly be welcome.

The award is made especially for the monograph on "The Horned Dinosauria or Ceratopsia," which is a very comprehensive and thorough piece of work. After an introduction on the stratigraphy of the formations in which remains of these incredible monsters have been discovered, and a section on their geographical distribution, which ranges from Mongolia to South America, the body of the work is given up to a description of the material scattered through the various museums of the United States and Canada. Then follows a description of the habitats and manner of life of these great reptiles, upon the problems of which much light was thrown by the Mongolian discoveries, the American Museum expeditions having collected several nests of *Protoceratops,* a small dinosaur of this group, in which many eggs were found just as they had been left by the mothers. Some of these were near to hatching and contained recognizable embryonic skeletons. Then finally there is a discussion of the evolution of this group throughout the Upper Cretaceous period, in which the great quantity of material is marshalled in an orderly way and their mutual systematic relations admirably discussed.

It should be added that the committee also had in mind the great body of Professor Lull's work on fossil mammals and his artistic achievements in the way of restoring these long-vanished creatures.

It is to me a particular pleasure to recognize the fine Yale tradition in vertebrate paleontology, which

[1] Presented at the annual dinner, Washington, D. C., April 25, 1939.

began with the work of Professor Marsh in 1859 and has continued with distinguished success and fine results until the present day, a period of 80 years. For a long time vertebrate paleontology in North America was practically confined to Philadelphia and New Haven; and in 1880 Sir Archibald Geikie published in *Nature* an article headed "Yale College and Palæontology," which was an enthusiastic description of the marvels that he had seen during a visit to Professor Marsh.

Another aspect of this work which deserves to be emphasized is the gratifying cooperation it indicates between all the museums of the country, such an infinite improvement over the state of more or less declared hostility and warfare in the days when the famous Marsh-Cope feud overshadowed all the paleontological work of the country.

W. B. SCOTT

RESPONSE BY THE MEDALIST

To paraphrase part of a note recently received from Japan: It is with "the greatest honour and unutterable throb of heart I feel in offering you this word of thanks."

I am in a sense a successor of Othniel C. Marsh, for twelve years president of this august body, whose vast collections at Yale and the United States National Museum have not only greatly enriched our science but given those of us who followed him a duty and a privilege beyond compare.

Marsh's collections were made with a view to monographing in succession great groups of animals. Of his projected memoirs but two were completed in his lifetime—the Dinocerata and the Toothed Birds. For the others beautiful lithographic plates were prepared and many species described in a great number of papers published in the *American Journal of Science*. Upon Professor Marsh's death in 1899 my own preceptor, Henry F. Osborn, succeeded him as vertebrate paleontologist to the United States Geological Survey and proposed to carry out Marsh's original plan. He realized that this was too great a task for any one man to accomplish, and, while reserving for himself the Brontotheres or Titanotheres, the Proboscidea and the Sauropod Dinosaurs, he delegated other problems to his associates.

One of these, the Ceratopsia, was entrusted to J. B. Hatcher, to whom Marsh had given the task of collecting Ceratopsian material from the famous locality in the Lance formation of old Converse County, Wyoming. Hatcher succeeded so well that he secured 30 odd skulls and much skeletal material now in the Yale Peabody and National Museum.

Hatcher worked diligently at his task and had finished the discussion of the history of discovery, the morphology and systematic descriptions when his hand too was arrested by death, leaving a bulky typescript but no further notes. My own connection with the work arose through having had some field experience in collecting Ceratopsia and in describing a skull which I had helped to collect, and as a consequence I was asked to complete the Marsh-Hatcher memoir. This was done, using so far as possible the conclusions of my predecessors, and the finished manuscript was presented to the United States Geological Survey for publication. A delay of one, two and finally three years made me begin to think that a strange fatality was in some way connected with the exploitation of these creatures of old, as in the case of King Tutankhamen's tomb, but by the grace of Providence I survived to see the memoir in its published form in 1906.

Since that time new discoveries have been made, especially in the Red Deer region of Alberta, where new forms came to light, dimly known in part from the earlier collections in the Judith River of Montana, but here displayed with such beauty and perfection of detail that one soon realized the incompleteness of the story as set forth in the memoir of 1906. Most of this new material was described by Lambe, Brown, Parks and others, but the need of assembling in memoir form the knowledge they had gained became more and more apparent. Having the facilities offered by a richly endowed chair at Yale and the courteous privilege of study in the several American and Canadian museums, we undertook the work, the result of which you have honored to-night.

It was fascinating to study the Ceratopsia, not as dry bones, but to visualize them as living creatures in an environment such as they may be found on earth to-day and to try to imagine their mode of life, their endowment of weapons and prowess, and why such apparent fitness availed them nothing when in the fullness of time their extinction came. Our task is that of a resurrectionist, for, as Robert Dick put it years ago,

> Hammers and chisels and a'
> Chisels and fossils and a'
> Resurrection's our trade
> For by raising the dead
> We've glory and honor and a'.

And when to this is added recognition by the National Academy of Sciences, one's cup is filled. For this culminating honor I thank you!

RICHARD SWANN LULL

PRESENTATION OF THE AGASSIZ MEDAL TO HARALD ULRIK SVERDRUP

IT is an honor to introduce to you as the duly selected recipient of the Agassiz Medal of the National Academy of Sciences for the year 1938 Harald Ulrik Sverdrup, Knight of the First Class of the Order of St. Olaf, member of the Academy of Science of Oslo, hon-

rary member of the Royal Meteorological Society of Great Britain, the German Meteorological Society and the geographical societies in many countries; the recipient of the Vega Medal in gold awarded by the Swedish Geographical Society, and of other medals and prizes; professor of geophysics in the Christian Michelsen Institute in Bergen, Norway, and director of the Scripps Institution of Oceanography of the University of California.

Before mentioning the accomplishments which constitute the basis of the award of the Agassiz Medal to Sverdrup a brief note will be made on the previous recipients of this medal. The medal was established in 1911 by Sir John Murray as a memorial to his friend, Alexander Agassiz. It was first awarded in 1913 to Johan Hjort. Between the establishment of the medal and 1938 it had been awarded sixteen times in thirty-four years. The countries of those to whom the awards had been made are as follows: Germany 1; Monaco 1; Netherlands 1; England 2; United States of America 3; Norway 4; Sweden 2; Denmark 2.

Prior to 1938 of the sixteen medals that had been awarded eight had gone to residents of Scandinavian countries, and four of the Scandinavians were Norwegians. We now add another Scandinavian, a Norwegian, to this list. Out of seventeen awards of the medal five have gone to Norwegians, giving clear evidence of the world leadership in oceanographic research of that country.

Before 1918, when Sverdrup took charge of the scientific work on the vessel *Maud* for Amundsen, although only thirty years of age, he had already published several important scientific papers. In fact, Sverdrup became an active producer of scientific papers as early as 1914, when he was only twenty-six years old, and he has since then, except while frozen in the ice on the north Siberian Shelf, had an unbroken record of important publications down to the present. In 1918 Sverdrup joined the *Maud* under Amundsen's general direction for a drift across the ice of the Polar Seas. The winters of 1918, 1919 and 1920 were spent frozen in the ice on the north Siberian Shelf. In 1921, however, the vessel needed repairs, and it went to Seattle, Washington, for reconditioning. During that time Sverdrup came to Washington, D. C., and spent his first winter here. The *Maud* left Seattle on June 3, 1922, and the winters of 1922, 1923 and 1924 were again spent frozen in ice in the Arctic Region. The expedition finally reached Nome on August 22, 1925, and the members of it were again in touch with civilization after an absence of three years and two months. On December 5, 1925, the party arrived at Seattle, Washington. Sverdrup spent, in the waters off the north Siberian Coast, six winters frozen up in the ice, except one escape. During this time he had many interesting experiences, some of which I trust that he will at least mention to you. During the winter of 1919, the one escape, he went from Ayon Island and joined the Chukchi tribe, with whom he spent seven months.

Sverdrup says in his general report on the expedition, "When the ship was underway under her own power, the scientific work was very limited and restricted to ordinary meteorological observations because the ship had no special crew, and we had all of us to act as sailors. My duties were, for instance, to take care of the navigation of the ship and of the cooking. When we were drifting with the ice the scientific work was, on the other hand, given much time and the scientists received assistance from every member of the expedition." It is not possible in the brief time allowable for this introduction to say more regarding the reports on the *Maud* expedition than that they contained numerous valuable contributions to different aspects of oceanography, particularly tides and currents, and to many aspects of geophysics.

In 1931 Sverdrup had charge of the scientific work on the submarine *Nautilus* with Sir Hubert Wilkins for an expedition to the Arctic, and he was author of the reports entitled, "Part I, Introduction and Narrative," and "Part II, Oceanography."

Sverdrup has prepared reports on the results of other expeditions such as the one conducted by Sir Douglas Mawson in Antarctic waters, and he contributed one chapter to the discussions of dynamical oceanography in the reports of the Discovery Committee on its operations in south Polar Seas.

Since going to the Scripps Institution of Oceanography at the end of August in 1936, Sverdrup has made many cruises in the waters within a few hundred miles of the California coast and has published a series of brilliant papers. During March of this year he organized and took part in an expedition to the Gulf of California which has given us the first really scientific information on the fundamental oceanographic features of that most interesting body of water.

From what has been said it is obvious that Sverdrup has taken part in many oceanographic expeditions. He has not only prepared reports on the results of these expeditions but has been one of the leading contributors to the theoretical aspects of oceanographic problems. He is also one of the world leaders in modern dynamical meteorology.

Enough has been said to make it clear that the Agassiz Medal is being awarded to the proper person, but before closing these remarks something should be said about Sverdrup the man. He has spent a great deal of time in America. It has already been mentioned that he was in Washington during the winter of 1921. It was then that I first became acquainted with him. He spent some time in Washington while he was preparing the scientific reports on the results

obtained on the *Maud*. He was entrusted with the preparation of those parts of the report on the results of the *Carnegie* expedition in 1928 and 1929 that deal with dynamical oceanography and other physical and chemical aspects of the sea. While these reports were in preparation he was in Washington for some time. He was one of the advisers for the National Academy Committee on Oceanography and went to Woods Hole during the summer of 1928 and spent some time with the members of the committee. I well remember the pleasure I felt when my wife and I reached Bergen in October, 1932, and Sverdrup was standing on the pier to welcome us. Our first meal in Norway was in his house. Numbers of Americans not only know Sverdrup's scientific work, but have an intimate personal acquaintance with him. He is a man of the finest character in every way, who has made friends with every one in this country who has had the good fortune to know him.

Mr. President, in presenting the Agassiz Medal to Harald Ulric Sverdrup you give worthy recognition to scientific achievement of a very high order of merit and give pleasure to the friends of a man who has endeared himself to many in this country.

T. WAYLAND VAUGHAN

RESPONSE BY THE MEDALIST

I WISH to express my deep appreciation of the honor which has been bestowed upon me by the award of the Agassiz Medal for contributions to oceanographic research. It makes me especially happy that the award has been made by the National Academy of Sciences of the United States, because it has been my good fortune to be associated with American institutions since my very first contacts with scientific work. As a graduate student I became in 1911 research assistant to Professor Vilhelm Bjerknes, who, thanks to a grant from the Carnegie Institution of Washington, was able to start young men on scientific careers. Thus, at that time I was already indirectly connected with that institution, which later on cooperated with the *Maud* Expedition, and of which I have been a research associate since 1928. Through my contact with the Carnegie Institution I have made friends in this country, and it is thanks to these friends that I now can take pride in being a member of the faculty of the University of California.

Dr. Vaughan has said too many kind words about my contributions. It is a somewhat doubtful pleasure to listen to a review of one's own merits, but for reasons which I should like to explain I am glad that Dr. Vaughan mentioned my work in the Arctic. Certain mental hardships of scientific Arctic exploration are rarely discussed. I am thinking of the feelings of uncertainty which often arise and which can not be dispelled because there is no adequate literature available for reference and no possibility for discussion with men of similar interest. On the *Maud* we started new investigations, we built new instruments, and I spent considerable time in theoretical studies of tidal currents. Although there were periods when I was so completely absorbed in the work that weeks and months passed quickly, there were other periods when I wondered and worried for fear I had made some elementary mistake, for fear the new investigations were suffering from systematic errors, for fear our new instruments did not perform as they should or that my theories were unsound. In such periods there was no one to consult, no literature to look up. Thinking back now I find myself again walking the deck of our vessel, turning the questions over in my mind, trying to find some flaw in my reasoning. In the end I always had to tell myself that, right or wrong, I was doing my best and would have to go on doing so, hoping that I was on the right track. Perhaps you will understand that an occasion like this brings ample compensation for all the hours of worry and uncertainty.

There is another matter I wish to mention to you. During the last winter in the Arctic, in 1924–25, we used to discuss what we wanted to do after returning to civilization. One of our party wanted to go to Peru, cross the Andes and, instead of drifting with the ice, to drift down the Amazon River on a raft. He did. I used to say that I should like an opportunity to do oceanographic work in the Pacific Ocean. It took me much longer to reach that goal. Although in 1930 I came into intimate contact with the problems of the Pacific through discussion of the excellent data collected by the *Carnegie*, it is only within the last three years that my wish has been actually fulfilled. In 1924–25 I thought of the Pacific Ocean as a pleasant contrast to the Arctic; now I am more than ever impressed by the tremendous amount of work as yet to be done in the Pacific Ocean, and by the fact that, in spite of the pioneering of Alexander Agassiz and Sir John Murray, large areas in the Pacific Ocean are still completely unknown from the point of view of the oceanographer. This fact has again and again been emphasized by Dr. Vaughan, who during his years as director of the Scripps Institution of Oceanography, greatly stimulated the interest in the exploration of the Pacific.

The Scripps Institution has a fortunate location and adequate resources for intensive studies of limited areas off the coast. While it can attack some of the many problems of the Pacific, a general exploration of the Pacific Ocean is an undertaking of such dimensions that no single institution can contemplate it.

Recently, Great Britain honored the memory of Sir John Murray by a "John Murray Expedition" to the Indian Ocean. It appears to me that the best manner in which the United States can honor the memory of Alexander Agassiz will be to organize a large-scale Alexander Agassiz Expedition for exploration of the Pacific Ocean.

HARALD ULRIK SVERDRUP

THE CHANGING OUTLOOK OF ENGINEERING SCIENCE[1]

By Professor R. V. SOUTHWELL

PROFESSOR OF ENGINEERING SCIENCE, UNIVERSITY OF OXFORD

BRIEFLY, here too my thesis is that we should avoid undue humility! The times are out of joint, and having attained to command of nature greater than the world has seen before, because man has not learned to use his mastery wisely, illogically now (as it seems to me) he inclines to question the value of that mastery, and the labors that have given it. In particular I want to record my protest against what seems to be an implication in much that is written nowadays, that because the range of engineering includes guns, battleships, aeroplanes, tanks, therefore engineers are to be regarded as a class more than others responsible for the horrors of modern war.

Here are words spoken by Sir Alfred Ewing, in a presidential address to the association (1932) which I keep to read ever and again, for its showing of what at the best an engineer's outlook may be:

> An old exponent of applied mechanics may be forgiven if he expresses something of the disillusion with which, now standing aside, he watches the sweeping pageant of discovery and invention in which he used to take unbounded delight. It is impossible not to ask, Whither does this tremendous procession tend? What, after all, is its goal? . . .
>
> The cornucopia of the engineer has been shaken over all the earth, scattering everywhere an endowment of previously unpossessed and unimagined capacities and powers. Beyond question many of these gifts are benefits to man, making life fuller, wider, healthier, richer in comforts and interests and in such happiness as material things can promote. But we are acutely aware that the engineer's gifts have been and may be grievously abused. In some there is potential tragedy as well as present burden. Man was ethically unprepared for so great a bounty. . . . The command of Nature has been put into his hands before he knows how to command himself.

Here too are words spoken somewhat earlier, in his wonderful James Forrest Lecture, 1928, on "A Century of Inventions." In them still more clearly, as I read them, he seems to feel as engineer a sense of special responsibility:

> I used, as a young teacher, to think that the splendid march of discovery and invention, with its penetration of the secrets of Nature, its consciousness of power, its absorbing mental interest, its unlimited possibilities of benefit, was in fact accomplishing some betterment of the character of man. . . . But the war came, and I realized the moral failure of applied mechanics. . . . We had put into the hand of civilization a weapon far deadlier than the weapons of barbarism, and there was nothing to stay her hand. Civilization, in fact, turned the weapon upon herself. The arts of the engineer had indeed been effectively learnt, but they had not changed man's soul. . . .
>
> Surely it is for the engineer as much as any man to pray for a spiritual awakening, to strive after such a growth of sanity as will prevent the gross misuse of his good gifts. For it is the engineer who, in the course of his labors to promote the comfort and convenience of man, has put into man's unchecked and careless hand a monstrous potentiality of ruin.

To which I personally would answer: "Yes, for the engineer as much as any man, *but no more.*" And when, in more recent pronouncements, I find the charge so glibly formulated—"It is engineers who have given men these potent weapons of destruction: on them *more than others,* then, rests the responsibility for their use"—then, admitting the premise, I protest against the deduction. I would say rather: "On them as much as on others (but no more) rests the responsibility for their use." Do not think that I imagine the load thus shared will be light for all. I have no illusion about the weight of responsibility—it is appalling; but I hold that we must share it equally, as citizens, not look for scapegoats when we have been free either to choose our path or leaders to direct us.

I can conceive no subject in which, more than this, clear thinking is wanted to-day: the desire to hand on responsibility is so deep-seated, and the will to believe that we could have had the benefits of science without its risks and its temptations. But knowledge is of good and evil: it is of its essence that we can not know how to cure poison without knowing poison and its action, how to control and use explosives without acquiring power for harm as well as good. We may elect either to shun it or pursue, but we can not have it both ways. Either we must choose, deliberately, impotence as preferable to the power of doing evil, or we must accept knowledge for the double-edged tool it is, vowing to use it wisely. We may not say to the scien-

[1] The concluding portion of the address of the president of the Section for Engineering of the British Association for the Advancement of Science, Cambridge, 1938.

tist, "Keep searching, but let your discoveries be such as must benefit and can not hurt us"; or pretend that the use we make of science is something outside our responsibilities as citizens, a thing imposed upon us by science itself. *Knowledge is not moral:* good and evil are its opposite sides, inseparable in its very nature. I have no quarrel (though no sympathy) with the plea we sometimes hear, for a cessation of scientific activity: it is arguable that on balance knowledge is undesirable. But when men talk of "beneficent" and "destructive" science as though we were free to pick and choose, then I say that they have not even begun to understand what science is.

Holding these views, I find it matter for regret that so often our concern with the impact of science on the life of the community, which is good and healthy, is expressed in a manner that is neither. Too often we seem to be weakly apologizing for results that have followed our activities, as it were because we did not take sufficient care. Need the geneticist apologize for having increased the earth's fertility, because we have found no better use for plenty than to destroy food while thousands are in want? Ought doctors to regret that by coming to a fuller understanding of disease they have lengthened the span of life in a world where birth rates are falling? Here and in countless other instances, science impinging on the life of the community has set problems that will tax to the utmost its courage and intelligence; the hardest and clearest thinking will be wanted, and it is right that engineers and scientists should seek to contribute their share. But I think that we only confuse the issue when we intervene *as specialists* in discussions which concern us really not as specialists but as members of a community.

Whether in these days, when all but a small minority seem convinced of the necessity of rearmament, the engineer is still regarded as scapegoat or has (for a time) been transferred to the rôle of savior, I have no means of judging. But if any still reproach him for making what all men now seek to buy, I would answer that horror is not peculiar to modern war; all war is horrible, both in nature and by purpose, and wars are made not by engineers but by communities. No war is righteous, though it seem so at the time; or inevitable, except as a penalty of national sins: pride, greed and indolence; and those more contemptible because weaker sins, vacillation of purpose, persistence in shams, clinging to safety even at the loss of honor.

More and more frequently, in lectures and in editorials, the decline of international standards is noticed with consternation and lament. Naturally, perhaps, in this country we are apt to see it mainly as an increasing tendency towards "repudiation of law and order in favor of brute force,"[2] revealed most clearly in states that have abjured the democratic ideal. But I think that the malady is at once deeper and more general. Dare we claim that our own policy has shown no falling away from earlier belief in straight-dealing, generosity and the sanctity of contracts?

Increasingly, as it seems to me, nations incline to put trust in the adroitness rather than the sincerity of their statesmen. Ethics are out of fashion, and while as individuals we may still admit the moral imperative, the notion that motives recognizable as moral can have place in international affairs seems now to be rejected as impracticable idealism. Force and deceit, it appears, although unpleasant are held to have "survival value": the gangster compels our unwilling admiration, at least in the field of world affairs. But what if there should be something in the notion, that because success in the life-struggle can come not only by individual strength but also by ability to associate and combine, morality has survival value as being (thus regarded) one of the factors which make association possible? A bank may come to ruin not only through fraudulent or incompetent direction, but because its depositors, panic-stricken, seek each his own legitimate interests at the expense of the common weal: may not a less narrow concept of moral obligation be necessary to the continuance of our civilization, even as wider than national horizons are necessary in the spheres of economics and finance? Perhaps this "idealism" is not so impracticable after all?

Collective security attained by higher standards of fair dealing—it is an epitome of man's progress from the cave to association in the village, in towns and in nations, and I see no ground for believing that the notion can never transcend national barriers. Men write as though it were new—a product of post-armistice utopianism. That it is not new let these sentences, none written less than 100 years ago, bear witness (Guedalla, 1931):

> Soyez sur qu'en politique il n'y a rien de stable que ce qui convient aux intérêts de tout le monde; et qu'il faut regarder un peu plus loin que soi-même.
>
> . . . although the aggrandizement and security of the power of one's own country is the duty of every man, all nations may depend upon it that the best security for power, and for every advantage now possessed, or to be acquired, is to be found in the reduction of the power and influence of the grand disturber.
>
> If we lose our character for truth and good faith, we shall have but little to stand upon in this country.
>
> I would sacrifice Gwalior, or every frontier of India, ten times over, in order to preserve our credit for scrupulous good faith, and the advantages and honor we gained by the late war and the peace. . . . What brought me through many difficulties in the war, and the negotiations for peace? The British good faith, and nothing else.

If this be utopianism, then some of our historical

[2] Vide *Nature*, May 28, 1938.

judgments will need revision; for all were said or written by Arthur, Duke of Wellington—a man not lightly to be charged with saying what he did not mean.

You will say, now I am drifting perilously near to politics! It is precisely the point I want to make: I say that inevitably, when instead of science we discuss its impact on the life of the community, we *must* verge on politics, because what concerns the community *is* politics, both etymologically and in fact. The old convention, that science should have no politics, seems to me sane and wise: how to preserve it if as scientists we are to concern ourselves with the life of the community, that is a question I must leave to others more subtly-minded. For myself I see no reason why as scientists we should meet to discuss anything but science. Contrary to common belief, it is not our habit to pursue science throughout the whole of every day; and on all counts I hold it were better that we came to political discussions in hours of leisure, unlabelled, than give support to a notion that political problems will yield to something known as "the scientific attack." Talk to me of the scientific approach in physics, and I shall have an idea of what you mean, though you will easily bewilder me with detail: talk to me of "scientific approach" to problems of real life, I shall suspect you of indulgence in mere jargon.

This is not to assert that science unfits a man for political discussion: if only because by training men of science are prepared to believe that problems of urgency may yet be hard, I hold on the contrary that some scientific leaven is beneficial in almost any body of administrative humanists. It is a protest against our facile modern use of the word "scientific" (which if it means anything connotes a special kind of approach to special problems) where "trained common sense" is the faculty which is really needed. In science we seek to explain phenomena which we believe to be outside man's control: it is the faith in which our work is done—for if the facts were not inexorable, and could be altered at man's pleasure, how could we hope to find enduring "laws"? But politics is concerned with action in fields where we believe that we can influence results: I see no reason to believe that the same technique will serve.

Rather than seek to defend our activities from the charge that evil can come of knowledge misapplied, might it not be better that we undertook a harder task, trying to instill into the mind of the public a clearer notion of the aims with which real scientific work is done? For what is that notion now, in these days of "popular science"? At best, a picture of life lived monastically by men who care nothing for the world outside their laboratories, but spend their energies unceasingly in the quest for more and more knowledge of less and less. (Is it surprising if the public question the right of such men to leisure, seeing that by their carelessness, as it appears, forces are unleashed which may bring our civilization to utter ruin?) At worst, an uncomprehended picture of modern "wonders of science"—gifts which these same men have conferred upon their fellows, altruistically wrestling from nature the secrets of spiritual and material benefit; so that somehow, while the astronomer fosters humility by telling the vastness of interstellar space, Heisenberg's principle of determinacy is thought to bring mystic comfort to men oppressed by the notion of all-pervading law. Equally unfounded, it is, I believe, the other side to that sense of responsibility for the consequences of science, about which I have spoken already; and on a more material plane it is the mainstay of the patent medicine business! For it has given us a public superficially acquainted with "recent progress in science," yet in reality no less ignorant, and more gullible, than was the public of Victorian days.

Never have greater powers of exposition been devoted to the "popularization" of science: when, I wonder, shall we find like powers devoted to the harder task of a real *apologia*? To telling, not of the treasure found, but of the quest; to showing the true man of science (for it is the fact) neither as care-free *dilettante* nor as philanthropist, but seeking truth like the artist, because he must? That, I maintain, is the real spirit of science, be it pure or applied; a spirit that breathes in every book of science worth the name: to make of difficulty a stimulus, to be unwearied in determination to do good work. Is it not there, rather than on a favorable trade-balance of benefits conferred, that we who have chosen science should stand in our defence? Were it not better that the public be told plainly: This is our work, which we do because we must?

A lead has been given, and we may be proud that the giver was an engineer; for the gleam is seen in that noble presidential address by Sir Alfred Ewing from which I have quoted already:

> The quest of truth goes on endlessly, ardently, fruitfully. And yet with every gain of knowledge we realize more clearly that we can never really know. To understand, as Einstein lately said, is to draw one incomprehensible out of another incomprehensible. From time to time we discover a fresh relation between observed phenomena, but each of the things which are found to be related continues to evade our full comprehension; and that is apparently the only kind of discovery we can achieve. Our joy in the quest itself never fails; we are constantly learning that it is better to travel than to arrive.

That I say is the spirit! Let us have the courage of the artist to exalt our calling, and while deploring

the folly that has led us and other men to misuse them, let us not weakly question that the gifts of science hold potential good. Fairly regarded, the record of engineering is not such that we need feel ashamed of our calling. Again, to quote Sir Henry Tizard (1938):

> There is nothing new in the fact that experiment and invention are transforming the habits of men and are adding to their problems. What is new is that we are all more aware of it, because the rate of change has been steadily increasing. . . . Bad news is, as a rule, better copy than good news. But can it seriously be argued that any section of society is worse off and living under worse conditions than a hundred years ago? Broadly speaking, the natural result of all scientific discovery has been greatly to improve the conditions of life and all our social relations, in spite of—or possibly even because of—the fact that scientific workers have been too busy doing their own jobs well to worry about other people's.

So Dr. Johnson to Mr. Boswell: "My dear friend, clear your *mind* of cant. . . . You may say, 'These are bad times; it is a melancholy thing to be reserved to such times.' . . . You may *talk* in this manner; it is a mode of talking in society: but don't *think* foolishly."

SCIENTIFIC EVENTS

SCHOLARSHIP AWARDS OF THE CANADIAN NATIONAL RESEARCH COUNCIL

THE National Research Council announces that forty-one awards of scholarships have been made for 1939–40. These scholarships form part of the means by which the council stimulates postgraduate training and scientific research in Canada. The successful candidates this year are drawn from fourteen Canadian universities. One of the candidates will study dairy bacteriology at the National Institute for Research in Dairying at Shinfield near Reading, England; all the others will carry on postgraduate research at Canadian universities. Three holders of special scholarships will be in training at the National Research Laboratories in Ottawa, where they will acquire experience in the study of industrial and commercial problems. Two of these scholarships have a value of $1,000 each and the other one is worth $750; four fellowships at $750 each and thirty-four studentships at $650 each are tenable at the universities.

Of the successful candidates for awards twenty will work in the field of chemistry, eight in physics, two in geology and one in engineering. In the biological sciences two will work in bacteriology, one in entomology, one in plant biochemistry, one in genetics and cytology, two in general biology and three in biochemistry.

In addition to the fellowships and studentships announced above provision has been made for a number of bursaries at $250 which are to be held under cooperative arrangements between the National Research Council and the universities in which the graduate students will be enrolled. Particulars of these further awards will be announced at a later date.

THE PERMANENT SCIENCE FUND OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES

INCOME from the Permanent Science Fund, according to agreement and declaration of trust, shall be applied by the American Academy of Arts and Sciences to such scientific research as shall be selected ". . . in such sciences as mathematics, physics, chemistry, astronomy, geology and geography, zoology, botany, anthropology, psychology, sociology and economics, history and philology, engineering, medicine and surgery, agriculture, manufacturing and commerce, education and any other science of any nature or description, whether or not now known or now recognized as scientific, and may be applied to or through public or private associations, societies, or institutions, whether incorporated or not, or through one or more individuals."

Applications for grants under this indenture are considered by a committee of this academy on stated dates only. The next meeting to consider applications will be held on October 1. Applications should be made on special forms furnished by the committee. Correspondence, including requests for application blanks, should be addressed to the chairman of the Committee on the Permanent Science Fund, Professor John W. M. Bunker, Massachusetts Institute of Technology, Cambridge, Mass.

Grants-in-aid from this fund were voted by the academy on April 12, 1939, as follows:

To Professor Emil Bozler, of the department of physiology, the Ohio State University, for the purchase of apparatus to be used in a study of action potentials of smooth muscle, $250.

To Dr. Donald E. Cameron, professor of neurology and psychiatry, Albany Medical College, for the purchase or construction of apparatus, as specified, to study the change in response to repetition of an unpleasant situation in psychotic patients, $200.

To Professor William H. Cole, department of physiology and biochemistry, Rutgers University, for technical assistance, materials and special apparatus for the determination of the chemical composition of the bloods of invertebrates, $500.

To Professor Robert S. Harris, department of biology, Massachusetts Institute of Technology, for the purchase of a newly developed instrument for optical quantitation of vitamin B_1, for a study of the daily requirement of

young and adult individuals in respect to this vitamin, $400.

To Dr. Caryl P. Haskins, Union College, Schenectady, N. Y., to aid in the construction of apparatus for studying the effects of proton bombardment of spores, $500.

To Professor Charles E. Lane, University of Wichita, Kansas, for technical assistance and materials in a study in the relationship between the pituitary, the ovary and the estrous cycle in rats, $300.

To Karl O. Lange, research meteorologist, Blue Hill Observatory, to aid in the construction and testing of automatic radio transmission of meteorological records to a central station, $300.

To Professor Willem J. Luyten, department of astronomy, University of Minnesota, as an aid in securing a supervisor for student measurements in his study of the proper motions of stars in the southern hemisphere, $500.

To Professor Hugh M. Raup, Harvard University, as a contribution toward general field expenses of a botanical survey of the southwestern part of the District of Mackenzie, contingent upon his securing necessary funds to assure the trip in the summer of 1939, $400.

To Professor Kenneth A. Siler, department of physiology and pharmacology, University of Arkansas School of Medicine, for the purchase or construction of necessary instruments in an investigation of the blood flow of the coronary system, $250.

AWARDS FROM THE MILTON FUND OF HARVARD UNIVERSITY

AWARDS in the sciences from the Milton Fund have been made as follows to instructors in Harvard University, to enable them to conduct research or prepare publications in the fields mentioned after their names:

Henry Asbury Christian, Hersey professor of the theory and practice of physics, for a study of the clinical medical records of the Peter Bent Brigham Hospital accumulated in the period 1913–39 under his direction as physician-in-chief.

William Dameshek, instructor in medicine, to extend previous investigations and make new ones on the etiology and treatment of certain hemolytic syndromes, with particular reference to the rôle of the spleen.

Ralph Eigil Fadum, instructor in civil engineering, for research on the stress-deformation characteristics of clays.

Knox Henderson Finley, instructor in psychiatry, for experimental studies with insulin and metrozol used in the treatment of dementia praecox, and to continue a study of the capillary beds of the hypothalamus with the aid of a cerebral blood vascular injection technique.

Alden Buchannon Greninger, assistant professor of metallurgy, for the purchase of optical equipment to aid in studies of martensite transformation in alloy systems.

Frederick Vinton Hunt, assistant professor of physics and communication engineering, to extend the results of an earlier investigation of auditorium acoustics by means of steady-state measurements.

Arthur Edwin Norton, Gordon McKay professor of applied mechanics, to continue a study of certain lubricants at or near the condition known as "apparent solidification" due to high local pressure.

John Rock, assistant in gynecology and research associate in obstetrics, and Austin Moore Brues, associate in medicine and instructor in biochemical sciences, for a study of ovulation, fertilization, nidation and electrical potentials associated with ovulation.

Reinhold Rüdenberg, Gordon McKay professor of electrical engineering, to investigate the extinction of electric alternating-current arcs by influencing the external circuit.

Karl Sax, professor of botany, for research on the effect of x-rays and neutrons on chromosomes.

Theodore Eugene Sterne, lecturer on astrophysics, for a spare moving system for a Paschen galvanometer and for repairs to the old system.

Theodore James Blanchard Stier, assistant professor of physiology, to continue the study of carbohydrate and lipid assimilation in yeast.

Paul Anthony Vestal, instructor in botany, to obtain information and specimens of the important plants (both cultivated and native) used by the Ramah-Atarque Navajo Indians.

Robert Weston Vose, instructor in applied mechanics, for a study of the aeolotropy of elasticity accompanying shear strain.

Ralph Hartley Wetmore, associate professor of botany, for studies in development and differentiation in the angiosperms.

George Bernays Wislocki, Parkman professor of anatomy, for a study of the anatomy of the manatee.

WINTER SCHOOL IN SOIL SCIENCE AT THE WAITE INSTITUTE

ACCORDING to *The Australian Journal of Science*, arrangements have been made for a Winter School for Soil Workers to be held at the Waite Agricultural Research Institute for ten days during the month of August. The school will be held under the auspices of the University of Adelaide and of the Council for Scientific and Industrial Research, and will open on August 14. Fees will not be charged, but all those attending must be accredited by their respective state departments, universities or other organizations.

It is believed that the school will be of value to soil workers, not only in the personal contacts that will be made and ideas interchanged, but that methods and procedures of established value will be brought to the notice of every one. These ends will be served by a series of lectures and demonstrations following a definite plan rather than by a conference of disconnected papers.

The lecturers and demonstrators will include Professor J. A. Prescott, C. S. Piper, Dr. A. Walkley, T. J. Marshall, C. G. Stephens, R. J. Best, T. H. Strong, J. S. Hosking and A. C. Oertel.

The following subjects have been chosen as likely to be of general interest. In most cases an introductory lecture will be followed by a practical demonstration:

climatology and soil classification, soil survey, texture, structure, color and water relationships of soils; minor elements in relation to plant growth; methods for the determination of trace elements, including chemical, spectrographic and polarographic methods; soil acidity and lime requirement, including use of the glass electrode; the conductivity method for the determination of soluble salts and the electrometric method for the determination of soluble chlorides; wet and dry combustion methods for the determination of soil carbon; soil-rhizobium relations; a one-day excursion through the country near Adelaide, with examination of several soil profiles.

Dr. A. Walkley, of the Waite Institute, is secretary to the school.

THE FIELD PROGRAM OF THE NATIONAL MUSEUM OF CANADA

SIX parties have been placed in the field this year by the National Museum of Canada, according to an announcement made by the Mines and Geology Branch of the Department of Mines and Resources, Ottawa. The program includes biological investigations in British Columbia and New Brunswick; botanical studies in Ontario; ethnological researches in British Columbia and the Prairie Provinces, and archeological work in Ontario and Quebec. The work is directed toward the gathering of new information on Canadian fauna and flora and native races, and the acquiring of new specimens for the National Museum.

C. M. Barbeau will make ethnological studies of the Indians of the northern coast of British Columbia, in a resumption of work first undertaken many years ago.

J. D. Leechman will collect anthropological specimens from the tribes of Indians of the Prairie Provinces.

W. J. Wintemberg will make excavations of prehistoric village sites at Tadoussac and Chicoutimi, Quebec, and at Dunnville and Port Maitland, Ontario. Last year he established the site of the Mission of St. Ignace II, the scene of the martyrdom of Fathers Bréboeuf and Lalemant.

H. M. Laing will continue the biological survey along the Pacific coast of British Columbia which has been in progress for some years.

T. M. C. Taylor will make a botanical survey in the vicinity of Heron Bay on the north shore of Lake Superior, Ontario.

W. E. Godfrey will collect zoological specimens and record wild-life observations in the western part of New Brunswick.

SYMPOSIUM ON GROWTH AND DEVELOPMENT

A SYMPOSIUM on "Growth and Development" will be held from August 7 to 11, sponsored by the editors of *Growth*, at Truro Central School, North Truro, Mass.

The announcement of the objects of the symposium reads:

> Biologists are finding themselves increasingly perplexed by the lack of an adequate conceptual framework with which to guide their own investigations and to bring the results of many specialized studies into a more coherent and meaningful relationship. There is an especially acute need for bridging the gap between genetics and embryology and examining the implications of highly diverse findings of experimental biology for an understanding of growth and development. The editors of *Growth* have therefore decided to inaugurate a Conference on Growth and Development at which discussions of these theoretical issues will be held in the hope of achieving some clarification and unification of thinking in these areas. Grants towards the cost of the conference have been received from the Macy and Rockefeller Foundations. Each session will be opened by a presentation of one paper, the discussion of which will be initiated by a designated leader for that topic, and during the course of the conference moving pictures related to growth and development will be shown. It is hoped that the last day of the conference may see some efforts at generalizing and synthesizing the outcome of the previous days' discussions. It is planned to issue proceedings of the conference, at least in summary form, as a supplement to *Growth*. It is expected that a society will be formed by persons interested in growth during the period of the conference.

The sessions will last from 9:30 in the morning to 3 o'clock in the afternoon, excepting on Friday, when there will be only a morning session.

The program follows:

August 7—"Cell Division and Differentiation," W. H. Lewis and P. W. Gregory.
August 8—"Genes and Development," Curt Stern and C. H. Waddington.
August 9—"Chemical Factors," J. Needham.
August 10—"Regeneration," O. E. Schotte; "Organization," E. W. Sinnott.
August 11—"Concept of Organism," J. H. Woodger.
Discussion Leaders—L. G. Barth, H. S. Burr, L. B. Clark, A. B. Dawson, O. Glaser, H. S. Greene, V. Hamburger, L. Rapkine, K. V. Thimann, Paul Weiss.

Members of the program committee are N. J. Berrill, C. B. Davenport and D. M. Whitaker. Those interested should write to Dr. Philip White, Rockefeller Institute for Medical Research, Princeton, N. J., or to Dr. F. S. Hammett, Provincetown, Mass., for specific invitation and for further information.

SUMMER MEETINGS OF MATHEMATICIANS

THE summer meeting and colloquium of the American Mathematical Society and the twenty-second summer meeting of the Mathematical Association of

America will be held at the University of Wisconsin on Monday and Tuesday, September 4 and 5.

The meetings of the American Mathematical Society will begin on Tuesday afternoon. A series of three colloquium lectures to be delivered by Professor M. H. Stone, of Harvard University, on "Convex Bodies" will be given on Wednesday morning, on Thursday afternoon and on Friday. A second series of four lectures by Professor A. A. Albert, of the University of Chicago, on the "Structures of Algebras" are planned for Tuesday afternoon, Wednesday, Thursday and Friday mornings. Sessions for the presentation of papers will be held on Tuesday and Thursday afternoons and on Wednesday, Thursday and Friday mornings.

A joint dinner of the society and the association will be given on Thursday evening at 6:30 at the Loraine Hotel. The charge will be $1.25 per plate.

Wednesday afternoon will be left open for recreation. No formal excursions are being planned, but boat rides, picnics, visit to the Forest Products Laboratory of the United States Government, a visit to the Banta Publishing Company or visits to near-by scenic spots may be planned. There will be informal teas in the refectory building on Monday and Tuesday afternoons, following the meetings.

SCIENTIFIC NOTES AND NEWS

AN oil painting of Dr. James B. Conant, president of Harvard University, previously Sheldon Emory professor of organic chemistry, has been presented to the university by the class of 1914, of which he was a member. The gift was made in connection with the twenty-fifth reunion of his class. It is planned to hang the painting in the faculty room of University Hall.

DR. JOSEPH SWEETMAN AMES, of the Johns Hopkins University, who became president-emeritus in 1935 and who, before his election to the presidency in 1929, was professor of physics, celebrated his seventy-fifth birthday on July 3.

MEMBERS of the American Committee for Democracy and Intellectual Freedom and others have signed a letter congratulating Dr. Franz Boas, professor emeritus of anthropology, Columbia University, on the occasion of his eighty-first birthday, which occurred on July 9. Messages have also been sent to him by President Roosevelt and Secretary Wallace.

A LUNCHEON in honor of Dr. Charles F. Kettering, president of the General Motors Research Corporation, will be given by the Chamber of Commerce of Los Angeles on July 18. Dr. Kettering will make an address entitled "Industry's New Horizons."

M. MARC TIFFENEAU, professor of pharmacology and materia medica in the faculty of medicine of the University of Paris, has been elected a member of the section of chemistry of the Paris Academy of Sciences, in succession to the late Professor G. Urbain.

THE degree of doctor of music was conferred at the commencement exercises of the University of Chicago on Dr. Carl E. Seashore, research professor of psychology and emeritus dean in the State University of Iowa, in recognition of "his contributions to the science of music."

THE honorary degree of doctor of science was conferred by Williams College at commencement on Dr. Louis Frederick Fieser, professor of chemistry at Harvard University.

BATES COLLEGE, Lewiston, Me., conferred on June 19 the degree of doctor of science on Dr. Herbert E. Walter, emeritus professor of biology at Brown University, and on Dr. H. O. Whitnall, professor of geology at Colgate University.

DR. GEORGE T. HARGITT, professor of zoology at Duke University, received the degree of doctor of science at the commencement exercises of Syracuse University.

TRINITY COLLEGE, Hartford, Conn., conferred on June 19 the doctorate of science on Dr. Willard Cole Rappleye, dean of the College of Physicians and Surgeons of Columbia University, who was the commencement speaker.

IN conferring the doctorate of laws on Dr. William Herbert Hobbs on June 17 at the University of Michigan the following citation was made by President Ruthven: "Professor of geology and director of the Geological Laboratory for twenty-eight years; since 1934 Professor Emeritus, whose achievements in science and influence in research will remain memorable in the annals of the University. To every task undertaken he brings an informed opinion and resolute will. His scholarly publications, many in number, range literally from pole to pole. Learned societies have elected him to office; mountains and glaciers bear his name; explorers buffeted by ice and storm value his share in their unending quest."

THE College of Physicians of Philadelphia awarded on July 14 the Alvarenga prize to Dr. Harry Goldblatt, professor of experimental pathology and associate director of the Institute of Pathology, of the School of Medicine of Western Reserve University, for his "contributions to the pathogenesis of hypertension." This prize was established by the will of Pedro Francisco

daCosta Alvarenga, of Lisbon, Portugal, an associate fellow of the College of Physicians, to be awarded annually on each anniversary of the death of the testator, July 14, 1883, "to the author of the best memorial upon any branch of medicine, which may be deemed worthy of the prize."

DR. WILLIAM WASHINGTON GRAVES, director of the department of neuropsychiatry at St. Louis University School of Medicine, has received the St. Louis Medical Society award of merit "in consideration of the results of his studies on inherited variations in relation to the problems of the human constitution."

THE Melchett Medal for 1939 of the British Institute of Fuel has been conferred on H. A. Humphrey, formerly consulting engineer to Imperial Chemical Industries, Ltd., for his work in "the development of fuel and appliances in connection therewith."

THE retirement from the faculty of Princeton University is announced of Professor Ulric Dahlgren, who has been connected with the university since his graduation in 1894, since 1911 as professor of biology.

AFTER serving for thirty-eight years as head of the department of chemistry of DePauw University, Dr. William M. Blanchard has relinquished his teaching duties, but will continue to serve for a time as dean of the College of Liberal Arts. Dr. Jesse L. Riebsomer has been appointed acting head of the department of chemistry for next year. Dr. J. C. Cowan, of the University of Illinois, has been appointed instructor in organic chemistry.

THE title of Dr. R. M. Ogden, dean of the College of Arts and Sciences at Cornell University, has been changed from professor of education to professor of psychology, and he will be in future a member of the department of psychology. He remains dean of the college.

DR. W. HALSEY BARKER, son of Dr. Lewellys F. Barker, of Baltimore, has been appointed to the newly established position of assistant dean of the School of Medicine of the Johns Hopkins University. He will aid Dr. Alan M. Chesney, dean, chiefly in the field of student relations. He will serve also as a member of the Committee on Admissions of the Medical School.

EDWARD SLATER SHEIRY, for six years head of the department of civil engineering in Robert College, Istanbul, has been appointed head of the department of civil engineering of Cooper Union, New York City, with the rank of full professor. He succeeds Professor Fred E. Foss, who retired in 1938 at the age of seventy-six years after serving for twenty-nine years. Assistant Professor Ray C. Brumfield has been acting head of the department during the past year.

M. G. EVANS, lecturer in physical chemistry in the University of Manchester, has been appointed to the chair of physical chemistry at the University of Leeds, in succession to the late Professor H. M. Dawson.

DR. JAMES WILFRED COOK, professor of chemistry in the University of London, has been appointed Regius professor of chemistry in the University of Glasgow, to succeed the late Professor George Barger.

PROFESSOR FRANK HORTON, university professor of physics at Royal Holloway College and a member of the Senate of the University of London since 1925, has been elected vice-chancellor for the year 1939–40. Professor A. W. Reed has been made deputy vice-chancellor. Lord Dawson of Penn, who has hitherto been a representative of the faculty of medicine on the senate, has been appointed a coopted member in place of the late Sir Frank Dyson.

DR. WILLIAM W. SKINNER has been appointed associate chief of the Bureau of Agricultural Chemistry and Engineering of the U. S. Department of Agriculture. In association with the chief of the bureau, Dr. Henry G. Knight, he will assist in the supervision and direction of all scientific, technical, engineering and administrative work, including the four Regional Research Laboratories authorized by the Congress to search for new and wider industrial outlets for agricultural commodities. Dr. Skinner has been a member of the Department of Agriculture since 1934.

DR. CHRISTIAN A. RUCKMICK, formerly professor of psychology at the State University of Iowa, is now associated with the C. H. Stoelting Company of Chicago, for fifty-three years manufacturers of and dealers in psychological and physiological apparatus and supplies. He has been appointed to the position of secretary and general sales manager formerly held by W. C. Wideman.

DR. ALEXIS CARREL, who is retiring as a member of the Rockefeller Institute for Medical Research, sailed for Europe on July 6.

DR. WALTER C. LOWDERMILK, chief of the division of research of the U. S. Department of Agriculture, who was invited by the Palestine Government to investigate the situation of conservation, has spent some weeks in making observations, which have extended into the Negeb and to the Aqaba area of Transjordan.

DR. FRED N. BRIGGS, associate professor of agronomy at the Agricultural College at Davis of the University of California, has sailed for Europe. He has leave of absence for six months which he will spend in visiting plant-breeding stations. He plans to attend the International Genetics Congress to be held this month in Edinburgh, Scotland.

DR. E. I. WHITE and W. N. Croft, both of the British Museum (Natural History), J. A. Moy-

Thomas, of Oxford, and J. Brough, of the University of Manchester, left England on June 24 to join the English, Norwegian and Swedish Geological Expedition to Spitsbergen. They expect to be away until towards the end of September. The expedition plans to collect remains of primitive vertebrate animals in the Wijde Bay area, from which little or nothing has hitherto been collected.

THE School of Medicine of the Johns Hopkins University and the Johns Hopkins Hospital will receive more than $1,000,000 by the will of the late Victor Morawetz, a New York attorney.

APPLICATIONS must be on file with the U. S. Civil Service Commission at Washington, D. C., on July 31 for the positions of meteorologist, at a salary of $3,800 a year; of associate meteorologist, at $3,200 a year, and of assistant meteorologist, at $2,600 a year. To become eligible, applicants must qualify in one or more of the following optional branches: eligibles are particularly desired who qualify in both Option 2 and Option 4, or who qualify in Option 2 and are trained in hydrology, or who qualify in Option 4 and are trained in oceanography: (1) Radiometeorography, (2) Synoptic Meteorology (Air Mass Analysis), (3) General Meteorology and Climatology, (4) Physical and Dynamical Meteorology, (5) Statistical Meteorology, (6) any other well-defined specialized branch of meteorology.

THE Cemenstone Corporation of Pittsburgh has established an industrial fellowship in Mellon Institute for conducting fundamental chemical and physical research on precast concrete units such as are being manufactured by the company. The main objective of the investigation is to develop practical methods and technics that will be of wide applicability in production. Donald R. MacPherson, for the past five years a member of the research staff of the Portland Cement Association in Chicago, has been appointed to the fellowship.

THE third International Congress for Microbiology will be held in New York at the Waldorf-Astoria Hotel from September 2 to 9. More than six hundred papers on a variety of subjects will be presented: for example, papers on bacterial variation and taxonomy, microbiological chemistry and physiology, viruses and viral diseases, rickettsiae and rickettsial diseases, fungi and fungous diseases (including bacterial diseases of plants), protozoology and parasitology, medical and veterinary bacteriology (including chemo- and serotherapy), industrial and agricultural microbiology and immunology. Any one interested in these subjects may attend the meetings. A registration fee of $5.00 will be charged. Those wishing to attend should communicate with the treasurer, Dr. Kenneth Goodner, Rockefeller Institute, York Avenue and 66th Street, New York, N. Y.

THE tentative program has been issued of the public health and nutrition section of the sixth Pacific Science Congress, of which Dr. K. F. Meyer is chairman, to be held from July 24 to August 12 at Berkeley, Stanford University and San Francisco, California. The program will be divided into four sections, as follows: Epidemiology of Diseases of the Pacific Basin; Nutritional Problems of the Pacific Basin; Industrial Hygiene; Health Education (to meet in joint session with the tenth annual meeting of the Western Branch of the American Public Health Association).

DISCUSSION

THE LUMINESCENCE OF SUGAR WAFERS

IF a "necco" wafer with a wintergreen flavor is broken in a dark room, a bright greenish flash of light appears, easily visible with dark-adapted eyes. This phenomenon is well known and is undoubtedly connected with the triboluminescence of sugar. The unusual aspect is the influence of the wintergreen flavor, for necco wafers with chocolate, liquorice and cinnamon flavors give no luminescence when broken and those with lemon, lime, clove and sassafras flavor give only a fair flash, about like that of lump sugar. The color of the wafer may be partly responsible for lack of luminescence, since dark-colored chocolate and liquorice-flavored wafers are not luminescent. However, the pink-colored sassafras-flavored wafer gives a fair luminescence, while the light orange cinnamon flavor gives none.

One necessity to obtain luminescence on breaking candy wafers is to have a mass of small sugar crystals, which are white, like snow. Thus, white "life savers" of wintergreen or clove flavor luminesce on breaking, but the mint, lime or cherry variety which are translucent and glass-like do not. Neither do "beechnut drops" of any flavor, also glassy, nor various taffies such as butter-scotch.

In a previous article[1] I pointed out that many triboluminescent crystals, such as salicylamid, salophen and uranyl nitrate, when crushed or shaken in a low pressure atmosphere of neon gas, still showed the bright greenish or colorless triboluminescent sparks with no trace of red which might indicate that the triboluminescence was an electrical discharge exciting the surrounding neon gas. Reddish electrical discharges can occur, however, when non-triboluminescent substances, such as chitin, diatomaceous earth or $KClO_3$ crystals, are broken in the neon atmosphere. Of special interest are sugar (rock candy) crystals, which

[1] SCIENCE, 89: 460, 1939.

gave a reddish luminescence when shaken in neon and some colorless triboluminescence also.

Longchambon[2] has observed the bands of nitrogen in triboluminescent sugar in air, and Wick,[3] in a thorough investigation of the general phenomena of triboluminescence, finds no triboluminescence of sugar when ground under xylol in a mortar. Both observations would indicate that sugar triboluminescence is mostly due to electric discharge in air. I have observed triboluminescence of sugar broken under various solvents, and additional experiments have led me to the belief that sugar molecules themselves can be excited to luminesce.

If a necco wafer with a wintergreen flavor is broken in a pure hydrogen atmosphere, in a vacuum (some air present, about 0.05 mm Hg) or in 10 to 20 mm neon there is always the greenish flash of light, of about the same intensity as in air. No red excitation of the neon occurs. Necco wafers and lump sugar will also luminesce if broken under water, 95 per cent. alcohol, acetone, toluol and xylol. Indeed, if soaked in alcohol, acetone, toluol or in xylol exhausted with an air pump for 5 minutes, to displace air between the sugar crystals, and then ground in a mortar, a triboluminescence appears in all solvents, brightest in the xylol and toluol and less marked in the acetone. I am therefore of the opinion that true triboluminescence of sugar (*i.e.*, excitation of luminescence in the sugar molecule) can occur as well as electrical discharges in the gas between sugar crystals. The reason the wintergreen-flavored necco wafer is particularly bright is because oil of wintergreen (methyl salicylate) is fluorescent and (1) excited to fluoresce by the triboluminescent light or (2) by electrical discharges when the wafer is broken. In ultra-violet light without the visible (mercury arc and Wood's filter), the wintergreen necco wafer is markedly bluish fluorescent, while lump sugar is practically non-fluorescent. The fluorescence of the wintergreen oil would add itself to the triboluminescence of the sugar when a necco wafer is broken.

E. NEWTON HARVEY

PRINCETON UNIVERSITY

HEPARIN AND THE INHIBITION OF BLOOD-CLOTTING

IN 1936 Fischer,[1] using a purified fibrinogen solution, showed that the clotting of this solution with calcium chloride and thrombokinase was not inhibited by even great concentrations of heparin. Inhibition only occurred after the addition of minute amounts of serium or plasma (fresh or heated to 56° C.). He offered no definite explanation to these experimental results.

Experiments, performed to obtain further information on this process and which are to be published soon, have now shown: (1) The method used by Fischer in purifying the fibrinogen is not very reliable in obtaining a fibrinogen free from prothrombin. A pure prothrombin-free fibrinogen does not clot by the addition of calcium chloride and thrombokinase; (2) solutions containing purified fibrinogen and prothrombin, together with $CaCl_2$, clot readily by the addition of thrombokinase. On this process heparin is without any inhibitory action; (3) plasma and serum contain substances which are necessary for the inhibitory action of heparin.

Heparin alone is thus without any activity against the clotting process, and the activity is due to the presence, together with heparin, of yet unknown substances present in serum and plasma. These experiments thus confirm the recent work of Brinkhous, Smith, Warner and Seegers,[2] and it seems worth while to note such simultaneous and independent, but identical, new results, since this has not happened very often in the history of blood coagulation. The literature concerning this subject is for the most part confused by controversial statements.

TAGE ASTRUP

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BORON AS A FERTILIZER FOR WESTERN OREGON SOILS

DURING the past decade studies have been conducted by the Oregon Experiment Station Soil Department with the aid of federal Adams funds to determine the value of the so-called minor elements in Oregon soil fertility and plant nutrition. Positive results have been secured with iodine, manganese, copper, zinc and boron. Response from iodine has been secured on Aiken silty clay loam and Deschutes sandy loam. Manganese and zinc have increased yields of certain crops on western Oregon peat. Copper has caused response with soils from the John Day and Illinois Valleys, while boron has been effective on most of the soil types used for alfalfa in northwestern Oregon.

Boron was shown to be essential to normal development of broad beans by Warrington in England in 1923. Boron has been used to control "top sickness" of tobacco, "brown heart" in turnips, "cork spot" in apples, "yellow top" in alfalfa and "crown rot" or "heart rot" of sugar beets, especially on soils of basic reaction. In the Pacific Northwest old soils, leachy soils or those derived from basaltic rocks seem more apt to be deficient in boron. Some unhealthiness in various plants formerly attributed to virus may be due to lack of boron. Soil reaction or lime and moisture

[2] *C. R. Ac. Sc.* 174: 1633, 1922; 176: 691, 1923.
[3] *Jour. Opt. Soc. Amer.*, 27: 275, 1937.
[1] A. Fischer, *Enzymologia*, 1: 81, 1936.
[2] K. M. Brinkhous, H. P. Smith, E. D. Warner and W. H. Seegers, *Am. Jour. Physiol.*, 125: 683, 1939.

contents, perhaps also temperature, may affect availability of boron.

In Oregon, recent experiments by the writer have demonstrated that yellow top of alfalfa can be controlled and yield strikingly increased on various soils by use of 30 pounds of boric acid an acre. Normal color was restored in the field within thirty days and with controlled conditions in the greenhouse within a few days. Bronzing and blighting of tops has been prevented and branching promoted.

Yellow top of alfalfa develops mainly under droughty conditions, although poor drainage may also lessen availability of boron. New leaves near the top of the stem become bronzed and then yellowish and tend to shatter off. The terminal bud and the blossoms may develop a blighted appearance. Application of boric acid or borax causes a lush green growth with branching of stems and, apparently, longevity of the alfalfa stand is promoted.

Boric acid has been used periodically in our experimental culture solutions for a decade to overcome a certain type of chlorosis or yellowing of foliage. One-half part per million has proven sufficient and may safely be used. The injurious effect of an excess is difficult to distinguish from that of a deficiency.

Chemical analyses of water, plant and soil profiles collected by the writer and made in our laboratories or by the U. S. Department of Agriculture show unfavorably low boron content in soils, waters and plants from affected areas. The use of boron to correct malnutrition has doubled boron content of plants, has slightly affected protein content and raised chlorophyll content 50 per cent. Boron content by the acid digestion method has ranged from 1½ part per million for peat to 7 parts per million for Willamette silty clay loam and is fairly uniform throughout the soil profile, though perhaps more available in the surface soil.

During the past three seasons in two dozen trials, use of boron on northwestern Oregon soils has controlled yellow top of alfalfa and trebled the yield for dry weather cuttings. Boron promises to be as profitable for western Oregon alfalfa land as sulfur has been in eastern Oregon. Similar symptoms have been observed and corrected on clovers and grasses.

Surface canker or "breakdown" of table beets has been controlled in the plant house and field in our experiments the past year perhaps for the first time. Canker caused rejection of whole fields of the 1937 crop.

Celery stem crack has been more completely controlled in field trials by Professor A. G. B. Bouquet and the writer where early applications were made. Assistance was given in treating some six acres.

Symptoms of boron "deficiency" disease, such as bronzing of tops and cracking at the nodes (or joints) with asters, broccoli and cabbage have led to boron applications to soil about these plants with promising results.

INDICATED EFFECTS OF BORON

(1) Boron may aid in the development of nodules on legumes.

(2) Apparently it is necessary for maintenance of elasticity and good condition of the conducting tissues and growing tip of the stem.

(3) It is apparently necessary for proper cell division and to the growing tip.

(4) Lettuce develops improperly in the absence of boron.

(5) May control nutritional deficiency diseases such as "heart rot" or surface "canker" of beets, "yellow top" of alfalfa and "stem crack" of celery.

(6) May aid availability of iron or of moisture.

(7) Boron may promote longevity and branching of alfalfa.

(8) Boron seems to improve keeping quality of apples.

There is less evidence of any deficiency of boron in eastern Oregon unless on neutral soils with rapid drainage. At the Hood River field station drought spot has been controlled with borax, and keeping quality of apples grown on Milton gravelly loam is reported by O. T. McWhorter to be improved. Use of boron with zinc is reported by Stephenson and Schuster to have been more effective in correction of little leaf of stone fruit trees near The Dalles.

While chemically pure boric acid was applied in dilute solution with a garden sprinkler in early, controlled experiments, the use of ordinary borax is usually cheaper for field use and will give similar results (unless on soils of basic reaction) if applied evenly and very early in the season. The boron treatment has been found to carry into the third season. Thirty pounds of borax may be evenly mixed with an equal amount of sandy loam or uniformly mixed with superphosphate or other fertilizer to dilute and aid evenness of application over each acre. The granular form has been successfully sown, as is clover seed. Slight temporary toxicity has followed application of 40 pounds of boric acid an acre to grass. Two pounds boric acid contain approximately as much of the element boron as does three pounds of borax. Borax may be secured of wholesale druggists or certain fertilizer dealers in Portland at about $3.25 per 100-pound bag. Several tons have been applied to western Oregon soils this 1939 season. It appears possible to increase the annual crop value in Willamette Valley at least $100,000 a year by the use of borax as fertilizer.

W. L. POWERS

OREGON AGRICULTURAL EXPERIMENT STATION

SOCIETIES AND MEETINGS

THE ANNUAL MEETING OF THE SOUTHWESTERN DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE Southwestern Division of the American Association for the Advancement of Science held its nineteenth annual meeting on May 2, 3, 4 and 5, in the extreme southeastern portion of its territory at Alpine, Texas, and the McDonald Observatory on Mt. Locke, forty miles from Alpine. Dates for the meetings were a week later than usual in order to make them coincide with the dedication of the new observatory. Inspection of the observatory, on May 2, and the dedication exercises, on May 5, were the unusual and distinctive features of the program. The attendance of the visiting astronomers who came to Alpine for the dedication ceremonies greatly enriched the meetings of the division. The delivery of the tenth John Wesley Powell Lecture by Professor Arthur H. Compton, on the topic "Physics Views the Future," was an outstanding event. The presidential address delivered by Dr. E. F. Carpenter, on the topic "The Revolt Against Thought," featured another evening of the sessions.

The attendance at the meetings was very good, particularly of those members who live in West Texas. The host institution, the Sul Ross State Teachers College, provided every facility possible for the comfort and entertainment of the visitors as well as presentation of the scientific features of the meetings. The exhibits at the museum of the West Texas Historical Society deserve special mention. In the business sessions the division voted to meet next year at Tucson, Arizona, with the University of Arizona, the Desert Laboratory and the Southwestern Forest and Range Experiment Station serving as host organizations. The meeting place for 1941 will be Lubbock, Texas, and for 1942, Las Cruces, New Mexico.

Officers of the division for the coming year, including those newly elected at the sessions, are as follows: *President,* J. R. Eyer, New Mexico State College, and *Vice-President,* C. V. Newsom, University of New Mexico. Dr. Emil Haury, University of Arizona, was elected as *Secretary-Treasurer* for the customary indefinite term of office. Members of the executive committee are as follows: E. F. Carpenter, University of Arizona, and S. B. Talmage, New Mexico School of Mines, who will serve until 1942; F. W. Sparks, Texas Technological College, and F. E. E. Germann, University of Colorado, who will serve until 1941; D. S. Robbins, State College, New Mexico, who will serve until 1940.

Section officers are as follows: Biological Section—*Chairman,* D. M. Crooks, University of Arizona, and *Secretary,* A. L. Hershey, New Mexico State College. Mathematics Section—*Chairman,* J. W. Branson, New Mexico State College; *Vice-Chairman,* E. J. Purcell, University of Arizona; *Secretary,* H. D. Larson, University of New Mexico. Social Science Section—*Chairman,* Emil Haury, University of Arizona; *Secretary,* Gordon C. Baldwin, University of Arizona. Physical Sciences Section—*Chairman,* C. W. Botkin, New Mexico State College; *Secretary,* O. B. Muench, New Mexico Normal University.

VEON C. KIECH,
Secretary

A SYMPOSIUM ON METRIC GEOMETRY

IN ordinary analytic geometry each point of the space is characterized by coordinates (each point of an n-dimensional space by n coordinates), and the distance between any two points is a certain function of their coordinates. At the beginning of this century this concept of space was remarkably generalized by Fréchet. He did not make any assumption concerning the nature of points. Points are simply elements of some set, not necessarily defined by coordinates or in any other particular way. Fréchet merely assumed that with each pair of points a number, called the distance between the two points, is associated. This concept was introduced in order to unify several classical theories into one general theory, an aim similar to that of E. H. Moore's general analysis. Since their introduction much has been learned of the topology of Fréchet's metric spaces, *i.e.,* of their properties of density, connectivity, etc. But only during the last ten years has a systematic theory of the metric properties of these general spaces been developd, *e.g.* of their convexity properties, their geodesics, etc. Recently L. M. Blumenthal summarized this theory in a book, "Distance Geometry," published in the University of Missouri Studies (Vol. XIII, No. 2).

This metric geometry was the subject of the third annual mathematical symposium held on April 12 and 13 at the University of Notre Dame. In the first meeting on April 12, Dr. L. M. Blumenthal, of the University of Missouri, spoke about the characterization of pseudo-spherical sets with application to determinant theory. A set is called pseudo-spherical if it can not be isometrically imbedded into the sphere though its subsets can. A set which can not be imbedded into the plane, though each subset can, consists of exactly five points, as it can be shown, and is called a pseudo-plane quintuple. Dr. P. M. Pepper, of the University of Notre Dame, presented some recent

sults on pseudo-plane quintuplets. He mentioned two surfaces slightly more complicated than the plane into which these quintuples can be imbedded. Dr. M. Sadowsky, of the Armour Institute of Technology, presented a new model of surfaces whose local metric is that of the Euclidean plane. Dr. L. M. Blumenthal gave a new metric characterization of the straight line.

On the following morning Dr. Marston Morse, of the Institute for Advanced Study, spoke about metric spaces related to the theory of critical points and applied in the calculus of variations. Dr. Karl Menger, of the University of Notre Dame, analyzed the minimum problem of the calculus of variations from the point of view of metric geometry. Dr. I. J. Schoenberg, of Colby College, dealt with the analytical aspects of isometric imbedding. The discussion was conducted by Dr. G. A. Bliss, of the University of Chicago.

The last meeting, directed by Dr. Marston Morse, dealt with the problem of imbedding metric spaces into Euclidean and more general spaces. Dr. Emil Artin, of Indiana University and the University of Notre Dame, dealt with the algebraic treatment of the question; Rev. B. J. Topel, University of Notre Dame, with imbedding into groups; Dr. A. M. Milgram, of the University of Notre Dame, with the imbedding of partially ordered sets into certain universal ordered sets. Dr. Karl Menger, of the University of Notre Dame, sketched a general theory of relation-preserving imbedding synthesizing these various theories.

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REPORTS

TRYPARSAMIDE IN THE CONTROL OF AFRICAN SLEEPING SICKNESS

RECENT reports on the progress of the extensive campaigns against African sleeping sickness (*T. gambiense* infection) indicate that the outlook for satisfactory control is much more promising than has heretofore been the case. This encouraging situation is directly associated with tryparsamide therapy, the effects of which were first demonstrated in the Belgian Congo in 1921.[1,2]

One of the major obstacles to a successful solution of the problem has been the failure of therapeutic agents in advanced cases, that is, those with involvement of the central nervous system. It is now known from the results of cerebrospinal fluid examination, moreover, that this involvement occurs much earlier than was formerly thought. Various drugs which are of benefit in the early phases of the infection are of little or no avail in later stages. Not only does the disease progress to a fatal termination, but the recurring presence of trypanosomes in the peripheral circulation constitutes a potential reservoir of infection. In marked contrast to these unsatisfactory results are those obtained with tryparsamide, the therapeutic action of which extends to the advanced stages. Because of this unique property, tryparsamide can be used in the routine mass treatment of both early and late cases.

Campaigns against sleeping sickness have long been a prominent feature of public health activities in the various colonies concerned, for control of the disease is a vital necessity to tropical Africa. A marked intensification of this work began some fifteen years ago, and it is significant that it was directly associated with the demonstration of the curative action of tryparsamide. An example of the notable results achieved is shown in the accompanying tabulation of official statistics of the Belgian Congo for the eleven-year period 1926–37, during which time tryparsamide has been increasingly employed.[3]

ELEVEN-YEAR RESULTS OF THE SLEEPING SICKNESS CAMPAIGN IN THE BELGIAN CONGO
1926–1937

Year	Number of natives examined	Old cases under treatment	New cases	Index of new infections, per cent.
1927	1,704,477	70,940	16,260	0.95
1928	2,126,356	46,372	24,440	1.16
1929	2,383,892	50,244	27,046	1.12
1930	2,779,448	70,423	33,562	1.20
1931	2,685,768	67,272	25,582	0.95
1932	2,832,083	77,268	21,346	0.75
1933	3,572,423	93,954	27,939	0.78
1934	3,824,097	86,147	24,101	0.63
1935	4,356,270	66,774	18,930	0.43
1936	5,282,646	53,429	18,708	0.36
1937	5,034,442	50,980	14,921	0.29

It will be noted that, although the number of natives examined annually for sleeping sickness was trebled in this period, that is, from 1,704,477 examined in 1926 to 5,034,477 in 1937, the index of new infections in 1937, 0.29 per cent., had fallen to one fourth the maximum figures of 1.16, 1.12, 1.20 per cent. in 1928, 1929, 1930, respectively. In addition, there was a marked decrease in the number of old cases continued under treatment from year to year, that is, from the high number of 93,954 in 1933 to 50,980 in 1937, a result of particular significance from the standpoint of efficiency of treatment.

Highly satisfactory results are reported by the Fonds Reine Elizabeth. This organization has had a wide experience in sleeping sickness work since 1931,

[1] L. Pearce, *Jour. Exp. Med.*, 24: 6, Supplement No. 1, 1921.

[2] L. Pearce, *Rockefeller Institute for Medical Research Monograph 23*, 1930, Science Press.

[3] L. Van Hoof; "Rapport sur l'Hygiène Publique au Congo Belge," 1937.

first in the Bas-Congo and, beginning in 1935, in the adjacent Kwango area, two provinces in which the disease is a particularly serious problem. The intensive five-year campaign in the Bas-Congo resulted in a decrease of the total endemic index of 2.49 per cent. in 1931 to 0.59 per cent. in 1936.[4] During two and one-half years in the Kwango, 35,099 patients were under observation, of whom 28,008 were considered to have been satisfactorily treated, 4,451 were still under treatment, 1,225 had died and 1,415 had disappeared.[5] The conclusion was reached that with adequate treatment more than 90 per cent. of curative results could be obtained.

A typical course of treatment comprises 1 gram of moranyl (germanine or Bayer 205) followed by 12 to 14 weekly doses of tryparsamide.[4] The average dosage of tryparsamide is 1.0 to 3.0 grams. It may be necessary to prolong or to repeat treatment in advanced cases.[2]

In the Cameroons (French Mandate) a similar intensive campaign has likewise included the use of tryparsamide, particularly in cases known to be advanced. The official medical report for 1936[6] states that in this year 515,933 persons of a population of 572,910 living in seven severely infected districts were examined. There were 24,006 old and 2,107 new cases. Of the old cases under treatment, it was found that 23,362 patients no longer had trypanosomes in the peripheral blood, while in 644 patients organisms were still present. Of special significance, however, from the standpoint of satisfactory treatment was the fact that during the year 11,659 patients were considered cured upon the basis of blood and cerebrospinal fluid examination. The precise system of treatment employed is not given in this report, but it is known from other sources that tryparsamide enters largely into the therapeutic procedures followed. Additional evidence of the progress of the work in the entire colony is afforded by the decline in the index of "circulating virus," that is, the proportions of persons in whom trypanosomes are demonstrated in the peripheral blood: 1932, 1.43 per cent.; 1933, 0.82 per cent.; 1934, 0.8 per cent.; 1935, 0.8 per cent.; and 1936, 0.56 per cent.

Recent surveys carried out in colonies west of the Cameroons show that sleeping sickness occupies a more important place among diseases than was hitherto supposed. This is the case, for instance, in Nigeria, where a sleeping sickness service was established in 1931. The official medical report for 1936[7] states that the total number of cases diagnosed and treated since the initiation of this service is 240,900, while 24,033 patients have been treated at general medical stations. During the year 1936, examination of 417,495 natives in the northern provinces of the colony revealed 47,550 cases, an incidence of nearly 11.5 per cent. An additional 14,571 cases were diagnosed and treated at field dispensaries and general hospitals, making a total of 62,021 cases treated in this year. The standard treatment now comprises three 1.0 gram doses of antrypsol or Bayer 205, followed by five 2.0 gram doses of tryparsamide.

Finally, attention should be directed to the fact that the introduction of tryparsamide therapy has resulted in the gratifying response of native cooperation in the treatment of both old and new cases. This significant change in the point of view of the native population which has been emphasized in various reports is obviously a factor of the greatest practical importance in the control of the disease.

The immense scope of the sleeping sickness problem is shown in a report of the League of Nations dealing with the geographical distribution of the disease.[8] From official data for 1935 or in a few instances for 1934, the following conclusions are drawn:

> In the African territories situated between the tropics, the total population of which may be estimated at 65 millions, nearly 7 millions were examined in the course of a single year. 140,000 fresh cases were discovered and treated, besides a similar number of old cases. In territories where the campaign has been going on for a long time (Belgian Congo, French Equatorial Africa, Cameroons under French Mandate), out of nearly 15 million inhabitants, the number examined in the course of a year exceeds 6 millions.

An effective therapeutic agent is a crucial factor in sleeping sickness campaigns, but the importance of other measures can not be overlooked. Authorities are well aware of the necessity of communal clearing directed against the tsetse fly and of the control of the movement and concentration of populations. Nevertheless, under the conditions now obtaining in tropical Africa, the successful solution of the problem must necessarily include the mass employment of therapeutic agents which are capable of curing not only early, but advanced cases. Up to the present time the only drug which fulfils this double requirement is tryparsamide. Future accomplishments based upon its widespread administration throughout infected areas are clearly foreshadowed by the unprecedented results already obtained.

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[4] De Brauwere, Fonds Reine Elizabeth. Rapport Annuel, 1936.
[5] *Ibid.*, 1937.
[6] Rapport Annuel du Territoire du Cameroun, 1936.
[7] Annual Report of Medical Services of Nigeria, 1936.
[8] Epidemiological Report (Sleeping Sickness) of the League of Nations, 1936, Nos. 10–12.

SPECIAL ARTICLES

EFFECT OF INDOLE-3-ACETIC ACID ON PHOTOSYNTHESIS

W. MITCHELL and CH. L. HAMNER[1] have recently shown that indole-3-acetic acid (heteroauxin) "stimulates plants to synthesize more solid matter, without causing a corresponding increase in leaf area." The authors' conclusion is based on experiments with young decapitated kidney-beans (*Phaseolus vulgaris*), where a lanoline paste containing indole-3-acetic acid was applied on the cut surface of the stem end. Such plants accumulated in the course of three days almost twice as much dry matter as did the control under identical environmental conditions. The control plants were also decapitated but treated with lanoline paste without heteroauxin.

The most probable explanation of the interesting fact established by Mitchell and Hamner is that heteroauxin from the paste on the cut surface penetrated into the green leaves of the experimental plants and intensified their photosynthetic activity. This assumption is supported by the experiments conducted by the authors during the summer of 1938.

Pairs of leaves were cut off from various plants (lilac, poplar, jasmine, hemp, hydrangea and others), care being taken to choose leaves as similar as possible in regard to age, size and position on the stem. The leaves were placed into two glass chambers, the lower ends of the leaf petioles being immersed in a Knop solution, and the intensity of photosynthesis determined. Electric lighting was employed. The surface of the chambers was cooled by a stream of running water in order to avoid overheating the leaves. The leaves were lighted for about one and three quarters of an hour. After several hours, a second determination was made of the quantity of carbonic acid decomposed by these leaves under the same conditions of lighting and in the course of an equal interval of time. These two determinations made it possible to estimate the photosynthetic activity of the leaves experimented on. It was expressed in milligrams of carbonic acid decomposed by one square decimeter of leaf surface in one hour.

One of the leaves was then immersed with the lower end of the petiole in a Knop solution containing 1 mg of heteroauxin per liter of water; while the other (control) was immersed in a Knop solution without heteroauxin. After several hours both leaves were again placed in the chambers and the intensity of assimilation was determined under the previous environmental conditions.

These experiments, repeated many times with various subjects, showed in the vast majority of cases a considerable intensification of photosynthesis under the influence of the indole-3-acetic acid introduced into the leaf. Thus, the hemp leaf, whose photosynthetic activity was expressed by figures of 10.00 and 9.60 mg in the first two determinations in the Knop mixture (with a four-hour interval between experiments), gave 19.24 mg and, in four hours, 18.00 mg of decomposed CO_2 after being kept in a Knop solution with heteroauxin (1 mg per liter) for nine hours. The control leaf gave the following values on parallel determinations: 12.10; 12.90; 14.73; 13.80. It should be noted that the photosynthetic activity in the control leaf kept in a Knop solution remained at the same level for the subsequent thirty hours; whereas, the experimental plant receiving the same solution with the addition of heteroauxin showed a considerable reduction of photosynthesis towards the end of the experiment (control, 14.83 mg; experimental leaf, 2.10 mg).

In another experiment on hydrangea, where the leaf was kept for 24 hours in a Knop solution with heteroauxin, the intensity of photosynthesis increased from 5.10 to 14.88 mg, while in the control leaf a decrease—from 3.34 to 2.14 mg—was observed.

Using higher heteroauxin concentrations (10 mg per liter) did not cause any changes in photosynthesis in our experiments.

Thus we arrive at the conclusion that indole-3-acetic acid causes a temporary intensification of photosynthesis on being directly introduced into the assimilating tissues of the green leaf in very low concentrations.

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[1] *Botan. Gazette*, March, 1938, p. 569.

GROWTH OF SOME HEMOLYTIC STREPTOCOCCI ON A CHEMICALLY DEFINED MEDIUM

HEMOLYTIC streptococci have previously been grown in complex media containing tissue extracts and have not been successfully cultured on mixtures of pure chemicals. Many problems dealing with the metabolic activity of these organisms would be aided if it were possible to know all the constituents of the medium on which the bacteria were grown. We have been able to obtain luxuriant growth of a representative strain of hemolytic streptococci on a medium containing only pure chemical compounds. The organism used was one of the Lancefield type D group, *S. zymogenes* strain H-6905.

We have recently shown[1] that a wide variety of hemolytic streptococci require riboflavin, pantothenic acid and a suitable reducing substance such as "reduced" iron. In addition, protein hydrolysates and

[1] D. W. Woolley and B. L. Hutchings, *Jour. Bact.*, in press.

aqueous liver extract are also required. We have now found that the protein hydrolysate may be replaced by a mixture of pure amino acids mixed in such proportions as to simulate the composition of casein. The liver extract[2] was purified by adsorption on and elution from lead sulfide, followed by adsorption on and elution from fuller's earth. The resulting concentrate was active at a level of 1 microgram per cc. The properties of the active material revealed by these concentration procedures led us to try various basic growth factors, and it was found that crystalline vitamin B_6[3] was effective.

Representative data illustrating the response obtained on our chemically defined media are shown in Table 1. The amino acid mixture supplied the following amounts of material per cc of medium: glycine 0.1 mg, dl-alanine 0.4 mg, dl-valine 1.6 mg, dl-leucine 1.0 mg, d-isoleucine 0.5 mg, dl-serine 0.2 mg, l-proline 1.0 mg, l-hydroxyproline 0.1 mg, dl-phenylalanine 1.0 mg, l-tyrosine 0.7 mg, l-cystine 0.1 mg, d-arginine hydrochloride 0.8 mg, l-histidine hydrochloride 0.4 mg, d-lysine hydrochloride 1.0 mg, l-tryptophane 0.3 mg, dl-methionine 0.8 mg, l-aspartic acid 0.5 mg, d-glutamic acid 2.5 mg, dl-threonine 0.6 mg. Growth was measured by quantitative determination of turbidity, as previously described. The figures in Table 1 represent the per cent. of the incident light which was transmitted by the culture. The pantothenic acid was supplied as a highly purified concentrate, but a synthetic product derived from di-hydroxy caproic acid was previously shown to replace it.

TABLE 1

Additions to glucose-salts medium	Photometer reading
(1) Riboflavin + reduced Fe + pantothenic acid	100
(2) (1) + amino acids	74
(3) (2) + vitamin B_6 (0.5γ/cc.)	10

It was noted that slight growth usually occurred when the amino acids, but not vitamin B_6, were added. This may possibly be due to contamination of some of the amino acids with the vitamin. It was not possible to supply every amino acid as a synthetic product, and while those that were not synthesized were carefully recrystallized, it may be that they were still contaminated.

The amino acid requirements for *S. zymogenes* have been determined on our medium, and glutamic acid and tryptophane were found to be essential. Details of the work, together with observations on a variety of species, will be published elsewhere.

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[2] We wish to thank Dr. David Klein of Wilson Laboratories for generous gift of this material.
[3] We wish to thank Dr. S. Lepkovsky for a sample of crystalline vitamin B_6.

THE PSEUDO-AMNION, PSEUDO-CHORION, PSEUDO-PLACENTA AND OTHER FOETAL STRUCTURES IN VIVIPAROUS CYPRINODONT FISHES

OVOVIVIPARITY or viviparity occurs in all species of four families of the cyprinodont fishes. Most of the specializations for viviparity in embryos and ovaries found in other viviparous fishes occur in this single order, and in addition there are unique features not found elsewhere. Within two of the families (Poeciliidae and Goodeidae) different species show degrees of specialization varying from simple conditions similar to those of oviparous fishes to extremes involving the partial degeneration of the yolk sac, and the development of new structures (pseudo-amnion, pseudo-chorion, pseudo-follicular placenta, trophotaeniae and gut modifications). Simple adaptations occur in the early embryos of extremely specialized forms, but these are ephemeral and are replaced in later stages of gestation by newer and more specialized structures. In the families Jenynsiidae and Anablepidae the living species have become highly specialized and no species retains simple modifications, except in early stages of ontogeny. There are numerous parallel developments in the four families.

The development, function and history of these adaptational structures is parallel roughly to that of the foetal membranes and yolk sac in the amniotes as a whole in the following respects:

(1) The yolk supply is adequate for nutrition up to the time of birth or hatching in some cases, but the yolk sac becomes degenerate in more specialized groups and the function of nutrition is taken over by new structures.

(2) Membranes or specialized organs functioning as respiratory, nutritive and excretory devices are developed from the somatopleure of the pericardial or peritoneal spaces and from the gut. They become highly vascular.

(3) In cases of advanced viviparity the uterus (ovary in fishes) becomes greatly modified.

(4) Foetal membranes or specialized structures are temporary and are discarded at birth.

Poeciliidae. The embryos are retained in the ovarian follicles for the whole period of gestation. In some genera (Mollienesia and others) the yolk sac is large and furnishes an adequate nutritional supply for the whole period of gestation. The somatopleure of the extra-embryonic pericardial cavity becomes vascularized, thus augmenting the respiratory surface, and lateral extensions fuse dorsal to the posterior head region to form a continuous band, a unique feature in this family. Specializations within the family are of two types. (1) *Heterandria formosa* and others have very small yolk sacs. The lateral extensions of the somatopleure of the extra-embryonic pericardial cavity completely envelop the head, forming an outer

vascular membrane (*pseudo-chorion*) and an inner non-vascular layer (*pseudo-amnion*) which is adherent to the embryo. The vascular membrane with its blood vessels derived from the old vitelline circulation is used as an organ for respiration and nutrition throughout gestation. The surrounding follicle becomes highly vascular and develops a layer of high, irregular columnar cells. (2) In Aulophallus and some species of Poeciliopsis which have small yolk sacs the lateral portions of the pericardial somatopleure are poorly developed, but the ventral portion becomes enlarged into an extensive vascular belly sac. The surrounding follicle develops on the internal surface an extensive system of anastomosing villi which are vascular and are covered with a secretory epithelium. The wall of the belly sac, together with the wall of the follicle with its villi, form a *follicular pseudo-placenta.*

Anablepidae. A more complicated and apparently more effective *follicular pseudo-placenta* has been developed in at least two of the three existing species of Anableps. The belly sac becomes very large and at an early stage takes over and expands the vitelline circulation. The blood vessels of the sac become expanded into rows of connected and projecting vascular bulbs. The surrounding follicle is covered on its inner surface with a mat of long vascular villi which are covered with a low epithelium.

The looped small intestine is everted into the cavity of the belly sac in *Anableps anableps.* In *A. dowei* the large intestine becomes a balloon-like sac which nearly fills the cavity of the sac. In both species there is a metamorphosis of the gut at birth involving shortening and reorganization. Follicular fluid is imbibed by the embryo and absorption takes place by means of specialized villi of the gut. The concentrated unabsorbed material is retained in the gut.

Goodeidae. In this family and in the Jenynsiidae the embryos are evacuated from the ovarian follicles into the ovarian cavity at early stages and develop in the ovarian cavity.

Goodeid species have various degrees of specialization in foetal structures. (1) In the primitive Ataeniobius the yolk sac is fairly large, and there is no expansion of the pericardial membrane. In late gestation the embryos imbibe ovarian fluid through an enlarged opercular opening and the mouth. (2) *Goodea luitpoldii* has a smaller yolk sac. The extra-embryonic pericardial sac is somewhat enlarged and vascular in early stages but recedes with the development of the trophotaeniae, ribbon-shaped outgrowths from the rectal lip which increase the absorbing surface. (3) Lermichthys, Neotoca and others have very small yolk sacs. Extensions of the pericardial somatopleure arise early but begin to recede at the thirty-five somite stage. A very extensive system of vascular trophotaeniae begins to develop at the twenty somite stage and with the recession of the extra-embryonic pericardial membrane takes over the functions of respiration and nutrition.

Jenynsiidae. In *Jenynsia* (*Fitzroya*) *lineata* the embryo augments the respiratory surface by expanding the vascular pericardial sac. The sac reaches the maximal size at the 6 mm stage at the point at which the yolk becomes exhausted. The pericardial sac begins to recede at this point, but in the meantime club-shaped vascular flaps grow out from the ovarian wall and extend into the branchial and mouth cavities through an enlarged opercular opening. Respiratory exchanges are accomplished by this device during the remainder of the gestational period, but nutritional materials are obtained by absorption from ovarian fluid imbibed through the mouth or opercular openings.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A THORACIC WINDOW FOR OBSERVATION OF THE LUNG IN A LIVING ANIMAL

DURING my investigation of the presence of fluid in the pulmonary air sacs a number of techniques have been tried to make these chambers accessible for observation in the living animal. Whereas this is a simple matter in the case of amphibians, it is not so in dealing with mammals, as every investigator who has approached the provinces of structure or physiology of the terminal spaces of the lung has realized. In attempts to overcome the difficulty of maintaining the lung under natural physiological conditions and at the same time having it available for observation and experiment, an instrument has been devised which is simple in construction, easy to adjust and which has proved successful for observations of the superficial air sacs and alveoli in the cat's lung. The principle of the method seems to be sound and practicable; some changes in the construction of accessory parts and in the means of illumination may be found desirable.

The instrument, made of bronze, consists of a short hollow cylinder, at one end of which is mounted a small cover glass window and at its opposite or internal end is formed a quadrilateral plate or flange. When adjusted in the thoracic wall, the cylinder projects through an opening made in an intercostal space, the plate fitting against the internal surface of the wall and the instrument fixed in place by means presently to be explained. When the air has been drawn out of the pleural cavity by an exhaust tube, the surface of the lung comes in contact with the window and remains there in view during respiration. Details of

the form and the dimensions of the principal parts of the instrument are shown in the accompanying figures.

The preferred points of opening the chest in an adult cat have been either the right second intercostal space or the right fifth intercostal space; the former because the movement there of the cephalic lobe is slight; the latter, chosen for manipulation of the ventral thin edge of the lung. In either case the pectoral muscles were divided and retracted (cat anesthetized with urethane), exposing intercostal muscles and the ribs. An opening barely large enough to admit the plate is made through the parietal pleura and the instrument, controlled by the handle, is introduced into the pleural cavity, then adjusted so that the cylinder stands between the two adjacent ribs. A piece of dental rubber dam somewhat larger than the plate and having a hole cut in the center to fit when stretched over the cylinder, is applied to the external face of the plate before the instrument is introduced into the chest. Fixation of the window in the thoracic wall is accomplished by screwing a flange upon the threaded cylinder down to the level of the ribs, thereby drawing the plate with its rubber mantle snugly against the internal surface of the thoracic wall. Two small lugs on the edges of the plate impinge upon the margins of the ribs, so that any tendency toward twisting of the window is prevented. By these means the window is incorporated in the chest wall, joints are sealed, and it moves with the movements of the wall in respiration, unless fixed, as it can be, by clamping the handle to the animal carrier.

Air that entered the pleural cavity when the window was inserted is removed by suction through an exhaust tube, whose bore opens internally immediately beneath the cover glass. When the last air is drawn out the surface of the lung strikes the glass with a noticeable clink. Clamping the suction tube maintains the vacuum. The cover glass, set in Canada balsam on a shoulder of the cylinder, is placed eccentrically in order to give room in the cylinder for the handle, the exhaust tube and a tunnel (Fig. 1, a). The latter goes very

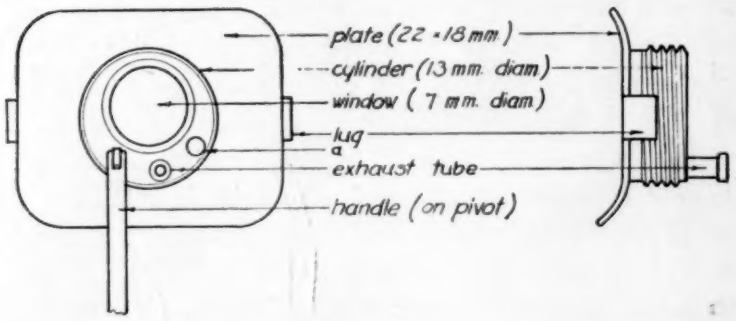

FIG. 1. Thoracic window.

obliquely to open beneath the cover glass and provides a way for experimental procedures, quartz rod lighting, etc.

Observations have been made with the binocular microscope and with a skin microscope; illumination for the former being an arc lamp, for the latter a 6-volt bulb. From both these sources of direct light the glare has been a disadvantage, controlled somewhat by the use of polaroid film. Experiments with quartz rod transmitted lighting are in progress. Good views of the superficial air sacs and alveoli have been obtained and a motion picture has recently been made recording such phenomena as could be brought forth with low power magnification and arc lamp illumination. With higher power lenses the capillary nets could be observed. Studies by means of the thoracic window are in progress and will be communicated in later publication.

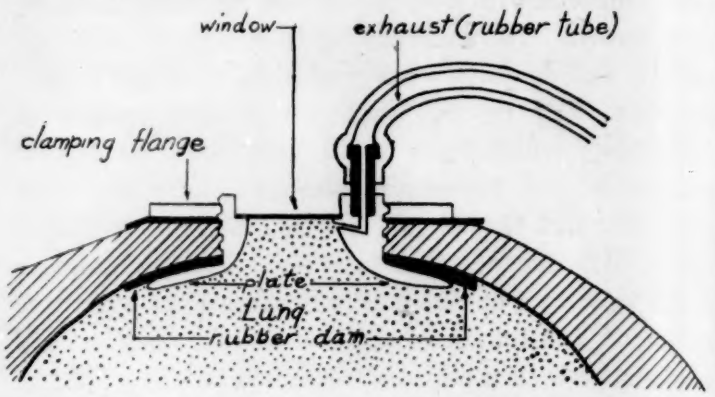

FIG. 2. Schematic transverse section of thoracic wall with thoracic window adjusted.

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